Instruction Manual 4219

Artificial Voice Type 4219

A sound source designed for use in development and production control of microphones and telephone transmitters under constant sound pressure and free field conditions in the frequency range 50 Hz to 10 kHz.

The sound pressure level can be kept constant (± 1 dB) with the aid of a built in microphone/preamplifier and the compressor circuit of a B & K sine generator.

Brüel & Kjær

033—0552

ARTIFICIAL VOICE
TYPE 4219

Revision May 1979

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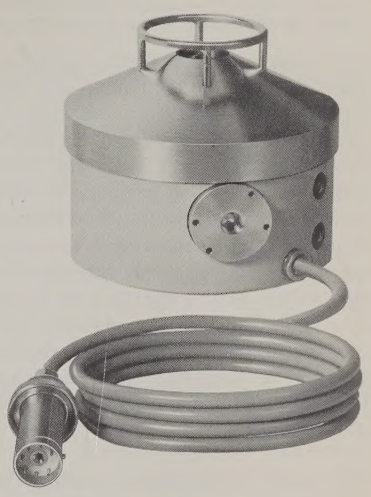
type 4219

Artificial Voice



FEATURES:

- Automatic control of sound level
- Frequency range 50 Hz to 10 kHz
- Built-in condenser microphone and preamplifier

USES:

- Frequency response and sensitivity measurements on small microphones and telephone transmitters
- As a regulated sound source in acoustic measurements

The Artificial Voice Type 4219 has been designed for use in development and production control of small microphones and telephone transmitters where a linear and well defined sound source is required.

The sound field produced by the Artificial Voice closely resembles the sound field from the human mouth. It covers the same frequency range and the sound level variation with distance is similar. See Fig.1.

The sound pressure at the orifice of the Artificial Voice can be kept constant (±1 dB) with the aid of the built-in condenser microphone/preamplifier and the compressor circuit of a B & K sine generator in the frequency range 50 Hz to 10 kHz.

The Artificial Voice has an extremely low output impedance, due to the regulation feature, making it useful for testing under constant sound pressure conditions. Typical applications for the Artificial Voice used under pressure conditions are the testing of microphones mounted in closed masks, testing of silencers, exhaust pipes, air inlets, etc.

Under free field conditions it is equally well suitable for near field measurements in testing of close talking microphones as it is for measurements in the far field at greater distances.

Application for near field measurements are the testing of handheld professional and semi-professional microphones for tape recorders, intercommunication systems, public address systems, dictating machines and telephone measurements.

Applications for far field measurements are the testing of hearing aid microphones, directional microphones, and room acoustic investigations. The acoustical properties of auditoria and theatres can be measured both at the design stage, by using a scale model of the auditorium, or as a final test upon completion of the auditorium, within the power limitations of the Voice.

The Artificial Voice consists of a small loudspeaker mounted in a metal housing, a mouth piece, a 1/4" regulating microphone mounted in the mouth opening and a built-in microphone preamplifier. See Fig.2. The mouth opening has a diameter of 20 mm. The microphone and preamplifier are supplied with the necessary voltages when the Artificial Voice is connected to any of the B & K Measuring Amplifiers, Frequency Analyzers and Microphone Power Supplies.

A typical measuring set up for automatic recording of the frequency response of a microphone is shown in Fig.3. The Sine Generator Type 1023, which has a compressor and

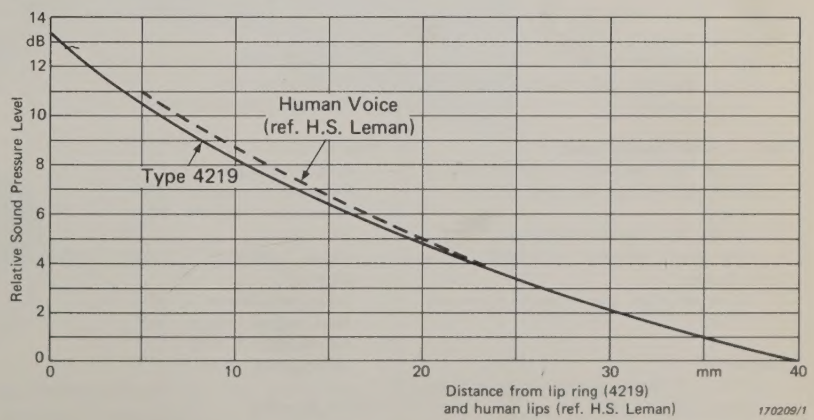


Fig.1. Variation of sound pressure with distance from 4219 lip ring, compared with measurements by H. S. Leman on human mouth using a test sentence. (Speech pressure near the human mouth. ICA IV, Copenhagen 1962, paper G 36). Sound pressure at 4219 measured with a continuously swept signal cycling from 200 Hz to 4 kHz to 200 Hz once per second

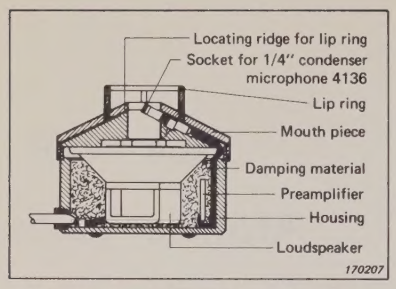


Fig.2. Sectional view of the Artificial Voice

automatic output voltage regulation, supplies the loudspeaker in the 4219. The signal from the built in microphone/preamplifier is amplified in a Measuring Amplifier Type 2606 before it is supplied to the compressor input of the Sine Generator. The compressor will keep the sound pressure level constant in the orifice of the 4219. See Fig.4. The signal from the microphone under test is amplified in the second Measuring Amplifier Type 2606 before it is supplied to the Level Recorder Type 2307.

In order to avoid overloading the loudspeaker of the 4219, when used in conjunction with Type 1023, a 10Ω/4W resistor should be inserted in series with the 1023 and the 4219.

For information regarding the use of the Artificial Voice for telephone measurements, see leaflet for Types 3354 and 3355 (Electroacoustic Transmission Measuring System and Objective Reference Equivalent Meter).

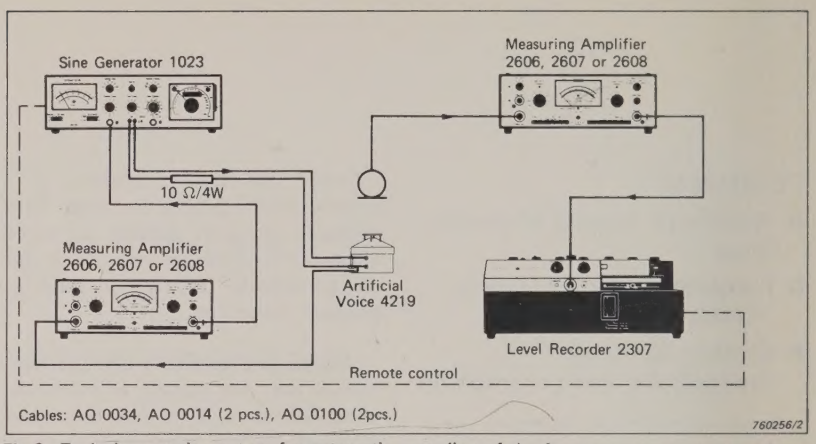

Sine Generator 1023
Measuring Amplifier 2606, 2607 or 2608
10 Ω/4W
Measuring Amplifier 2606, 2607 or 2608
Artificial Voice 4219
Level Recorder 2307
Remote control
Cables: AQ 0034, AO 0014 (2 pcs.), AQ 0100 (2pcs.)
760256/2

Fig.3. Typical measuring set-up for automatic recording of the frequency response of a microphone

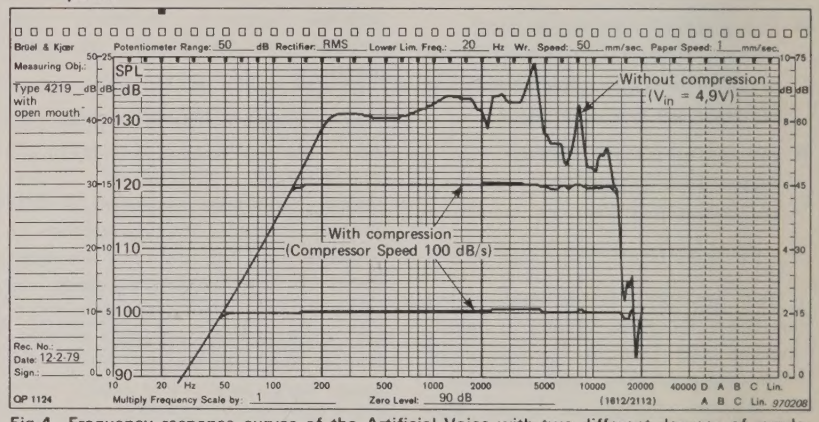


Fig.4. Frequency response curves of the Artificial Voice with two different degrees of regulation and without regulation

Specifications 4219

Frequency Range:
50 Hz to 10 kHz ± 1 dB
(with regulated SPL up to 100 dB at mouth opening)

Max. Sound Pressure Level:
115 dB for free-field measurements at the front of the lip ring (200 Hz to 10 kHz)
140 dB for measurements under constant sound pressure conditions (50 Hz to 3 kHz)
(Obtained when connected to Generator 1023)

Distortion:
< 1% at 1 kHz at sound pressure levels lower than 115 dB
(measured with built-in microphone)

Loudspeaker:
Power handling capacity: 3 W
Impedance: 8 Ω
Diameter: 90 mm (3,5 in)

Preamplifier:
Supply voltage: 120 V
Polarization voltage: 200 V
Frequency range*: 20 Hz to 20 kHz ± 0,5 dB
Noise voltage*: < 100 μV (20 Hz to 20 kHz)
Input capacitance: < 1 pF
Max. output voltage: 30 V
Attenuation: 0,1 dB
Attenuation*: 1 dB

Mouth Opening:
Diameter: 20 mm (0,8 in)

Lip Ring:
Position: 10 mm (0,4 in) from mouth opening
Outer diameter: 48 mm (1,9 in)

Dimensions:
Height: 90 mm (3,5 in)
Diameter: 100 mm (4 in)

Weight:
1,25 kg (2,8 lb)

Accessories Included:
Type 4136: 1/4" condenser microphone

* 6 pF at input (6 pF corresponds to microphone Type 4136)

2. OPERATION

2.1. CALIBRATION

The Artificial Voice Type 4219 with a built-in Condenser Microphone Type 4136 is normally used with one of the B & K Measuring Amplifiers. Before use it is necessary to carry out an acoustic calibration of the set up, and for this purpose it is recommended to use the Pistonphone Type 4220. This gives a sound pressure level of 124 dB which is sufficient for calibrating relatively low sensitivity microphones. The Pistonphone should be fitted with a 1/4 inch adaptor, and the Measuring Amplifier with the appropriate meter scale for sound pressure measurements. The meter scale must be suitable for use with microphones with a sensitivity of 1,6 mV/Pa, which is the nominal sensitivity of the Microphone Type 4136. See Instruction Manual for particular Measuring Amplifier used.

Access to the microphone can be obtained by unscrewing the mouthpiece. In order to fit the Pistonphone on the microphone it is necessary to release it from the spring clip holding it in position in the centre of the orifice. See Fig.2.1. Full instructions for calibration can be found in the instruction manuals for the Pistonphone and the Measuring Amplifier. After the calibration, the microphone is replaced in the spring clip, and the mouthpiece replaced. The Artificial Voice can now be used as a calibrated sound source.

Fig.2.1. Fitting the Pistonphone on the Condenser Microphone built into the Artificial Voice.

2.2. SETTING UP THE 4219 WITH CONSTANT SOUND PRESSURE LEVEL

To provide a constant sound pressure level from the Artificial Voice the arrangement shown in Fig.2.2 may be used. The loudspeaker in the Artificial Voice is fed from the Sine Generator Type 1023 via a 10Ω/4W resistor, and a Measuring Amplifier is used to amplify the feedback signal to the compressor in the generator.

The signal from the Measuring Amplifier is also supplied to the Level Recorder Type 2307, which records the result on frequency calibrated paper.

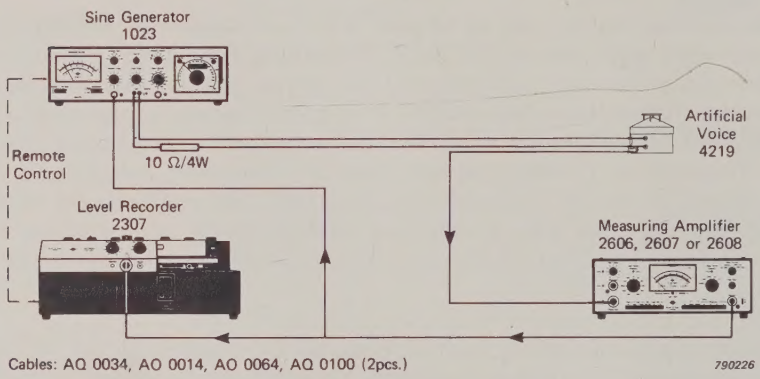


Fig.2.2. Arrangement for setting up the 4219 with constant sound pressure level

The procedure described in the following can be applied for both the constant sound pressure and the free field case.

1. Calibrate the microphone in the Artificial Voice as described in section 2.1.

2. Connect the instrumentation as shown in Fig.2.2 with a resistor in the supply lead from the Sine Generator to the Artificial Voice. For synchronisation between the Level Recorder and the Generator, use a standard 8 pin DIN cable AQ 0034 between X — REC on the Level Recorder and FREQ. CONTROL VOLTAGE IN on the Generator. The generator frequency will then be controlled by a synchronisation voltage from the Level Recorder.

3. On the Generator set:

Generator operation controls:

POWER	"Off"
GENERATOR	"On"
REF. SIGNAL	"Off"
SWEEP CONTROL	"Log" and "Manual Ext. Mech"

Frequency related controls:

MODULATION FREQUENCY	"Mod Off"
COUNTING TIME	"0,1 s"
FREQUENCY DIAL	"50" on the inner scale

Compressor controls:

COMPRESSOR SPEED	"100 dB/s"
COMPRESSOR VOLTAGE	"0"

Output controls:

OUTPUT ATTENUATOR	"Load"

4. On the Measuring Amplifier set:

GAIN CONTROL	"Cal."
INPUT SECTION ATTENUATOR	"10 mV" equivalent to "100 dB"
INPUT	"Preamp."
FILTERS	"22.5 Hz"
OUTPUT SECTION ATTENUATOR	"× 1"
METER FUNCTION	"RMS fast"
OUTPUT MODE	"AC"

5. On the Level Recorder (fitted with Potentiometer ZR 0005 and Recording Paper QP 1124) set:

POTENTIOMETER RANGE	"50 dB"
RECTIFIER RESPONSE	"RMS"
LOWER LIMITING FREQUENCY	"20 Hz"
WRITING SPEED	"50 mm/sec"
PAPER DRIVE FUNCTION	"Automatic Stop — F"
AUTOMATIC STOP	White spot in top position
PAPER DRIVE	"On"
INPUT POTENTIOMETER	"0"
INPUT ATTENUATOR	"10"

6. Switch all POWER switches to "On".

7. Adjust the drive signal go give a constant sound pressure level at 100 dB re $2 \times 16/10^{-5}$ N/m^2. To do this increase the OUTPUT VOLTAGE on the Generator until the meter on the Measuring Amplifier indicates a sound pressure level of 101 dB and then turn the COMPRESSOR VOLTAGE knob on the Generator until the sound pressure level has been reduced to exactly 100 dB.

8. Adjust the INPUT POTENTIOMETER on the Level Recorder to give a pen deflection on one of the thick lines on the recording paper. This line will then indicate a level of 100 dB.

9. Slowly increase the frequency and check that there is no discrepancy between the meter deflection on the Measuring Amplifier and the movement of the pen on the Level Recorder. If there is a discrepancy it might be caused by an earth loop in the measuring set up. This loop can be broken by disconnecting the signal earth lead to the Level Recorder.

10. Switch the SWEEP CONTROL on the Generator to "Ext. Electr.", press the START button on the Level Recorder and let the paper run until it stops automatically. Lift up the paper guide clip holding the paper pressed against the paper drive sprocket wheel of the Level Recorder and move the paper so that the frequency directly under the pen is the same as the frequency displayed on the Sine Generator.

11. To commence recording press the START button. The Level Recorder will automatically plot out the frequency response of the sound pressure level in the orifice of the Artificial Voice. The paper will stop automatically, when the stop position on the next chart on the recording paper is reached. The recorded frequency response can be used as reference documentation when the Voice is used for testing the frequency response of a test object e.g. a microphone.

12. The lead carrying the signal to the Level Recorder can now be disconnected and the Level Recorder can be used for recording a signal from the object to be tested. See section 2.3.

The procedure described above explains how to adjust the Artificial Voice to give a constant SPL of 100 dB. This is the maximum regulated level (± 1 dB) with open mouth, which can be obtained over the full specified frequency range 50 Hz to 10 kHz. A higher level can be obtained, but only for a more limited frequency range. See Fig.3.4 in section 3.2. If a constant SPL below 80 dB is required it is necessary to reduce the Generator OUTPUT level in order to get the compressor in the Generator to operate inside its working range of 60 dB.

2.3. RECORDING THE FREQUENCY RESPONSE OF MICROPHONES

The set up shown in Fig.2.3 can be used for testing microphones under conditions similar to the intended working conditions. The set up is similar to the set up in Fig.2.1 with the addition of the microphone to be tested and a Measuring Amplifier (2). The Measuring Amplifier (2) amplifies the signal from the microphone under test before it is supplied to the Level Recorder for recording. Before starting measurements on the microphone to be tested it is important to adjust the constant sound pressure level as described in section 2.2 and the result should be recorded on the Level Recorder to check that the level is constant at all frequencies over the range of interest.

The instrumentation in Fig.2.3 is not the only combination of B & K instruments which can be used for automatic recording of the frequency response of microphones. For example could the Sine Generator Type 1023 and the Measuring Amplifier be replaced by the Heterodyne Analyzer Type 2010. The procedure for setting up the compressor loop with the Heterodyne Analyzer is similar to that described in section 2.2.

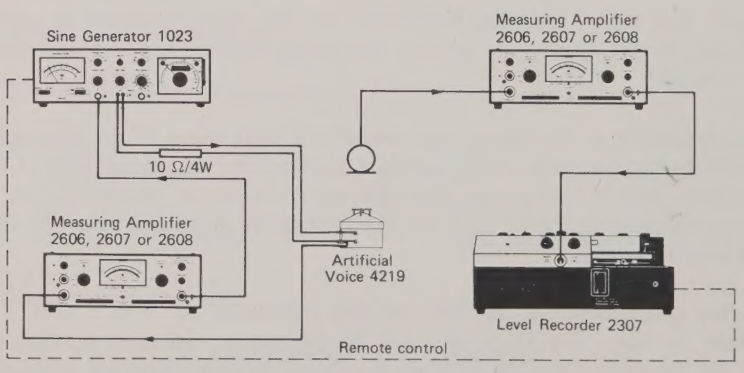


Fig.2.3. Typical measuring set up for automatic recording of the frequency response of a microphone

2.4. TELEPHONE MEASUREMENTS

The Artificial Voice is an integral part of the Electroacoustic Telephone Transmission Measuring Systems Types 3354 and 3355, where it is used as the sound source in the testing of telephone transmitters and complete hand sets. Fig. 2.4 shows the Artificial Voice mounted in the Telephone Test Head Type 4905 for measurement on a hand set. For information on this application refer to the Instruction Manual for the 3354 and 3355 systems.

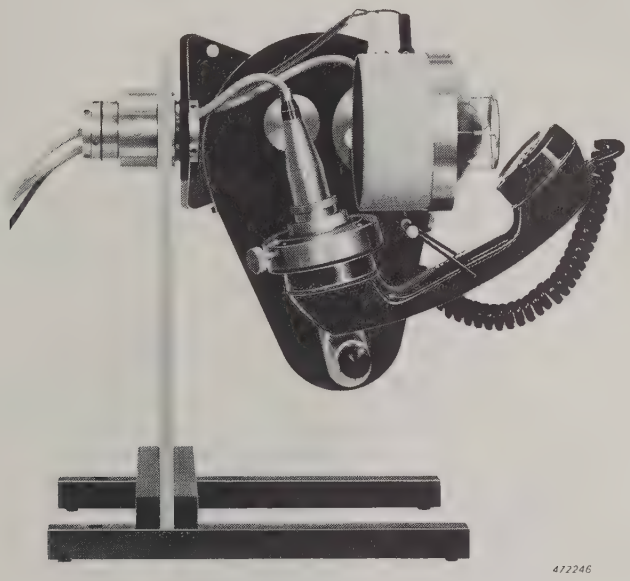


Fig.2.4. The Artificial Voice mounted in the Telephone Test Head Type 4905

3. OPERATING CHARACTERISTICS

3.1. CONSTRUCTION

The Artificial Voice consists of a small dynamic loudspeaker of 90 mm diameter, mounted in a rigid walled aluminium housing. The impedance of the loudspeaker is 8 Ω and it has a maximum power handling capacity of 3 W.

The removable mouthpiece is located in front of the loudspeaker, and it has a circular opening of 20 mm diameter. A 1/4 inch Microphone Type 4136 is mounted at an angle below the mouthpiece, with the diaphragm in the centre of the orifice. The microphone is screwed onto a microphone connector, which is clipped into a groove in the housing of the Voice.

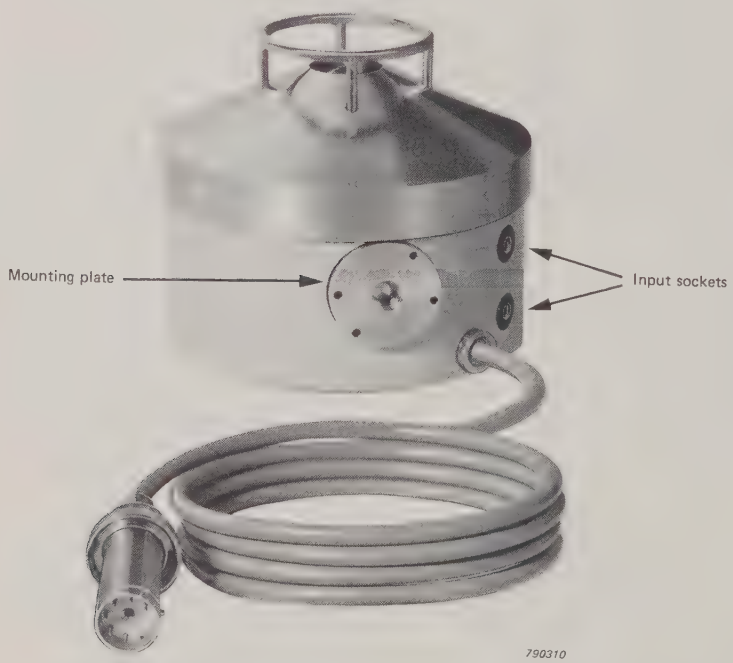


Fig.3.1. The Artificial Voice exterior showing the mounting plate and the loudspeaker input sockets

A lip ring is mounted on the mouthpiece and positioned 10 mm above the mouth opening. The outside diameter of the lip ring is 48 mm. The pressure drop with distance from the plane of the lip ring is similar to the pressure drop with distance from the lips of a human source. The lip ring can be used as a reference plane when taking measurements at various distances from the Voice. The lip ring can be removed to allow direct pressure measurement or to allow the mounting of special jigs. It may be removed by unscrewing the mouthpiece and removing the four retaining screws on the inside of the mouthpiece. The screw holes may then be used to mount special jigs if required.

The position of the orifice and lip ring have a definite position relative to the body of the Voice. This relative position is defined by the locating ridge below the mouthpiece. See Fig.3.2. The ridge is accurately machined with respect to the mounting plate shown in Fig.3.1. When the mouthpiece is screwed onto the Voice, it locates against this ridge. Hence the lip ring located on the mouthpiece is placed so that there is a precise and known relation between the position of the lip ring and the mounting plate.

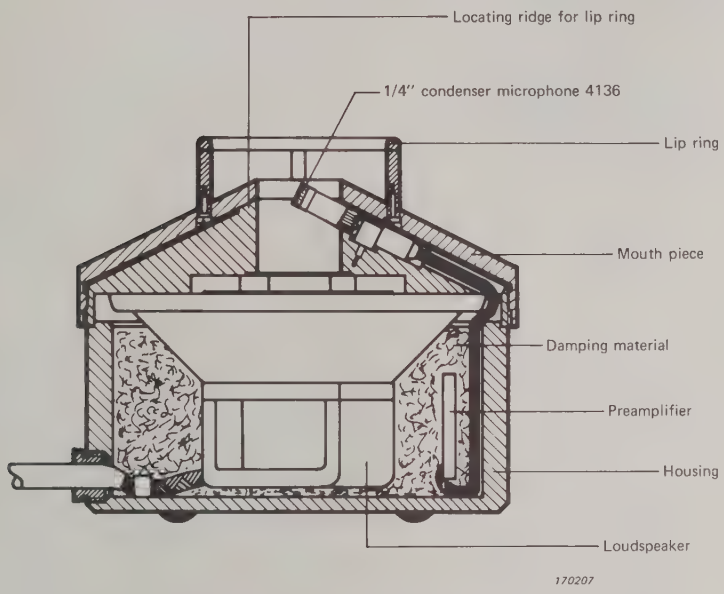


Fig.3.2. Sectional view of the Artificial Voice Type 4219

The mounting plate is drilled, and tapped with 3/8 inch W thread and has four locating holes on its flat surface. These locating holes are intended for use with the B & K Electroacoustic Telephone Transmission Measuring System Types 3354 and 3355.

The Artificial Voice has its own built-in microphone preamplifier, so no other preamplifier is required. The preamplifier cable attached to the Voice is 2 m long and terminated in a B & K standard 7 pin plug Type JP 0701. This plug fits into the PREAMP. INPUT of a B & K Measuring Amplifier which also supplies the power for the preamplifier and the polarisation voltage for the condenser microphone. The attenuation of the preamplifier and cable, when used with the 1/4 inch Microphone 4136, is approximately 1 dB.

3.2. FREE FIELD CHARACTERISTICS

3.2.1. Frequency Response

The free field frequency response curves of the Artificial Voice were measured using the set up shown in Fig.3.3. Typical frequency response curves are given in Fig.3.4.

The sound pressure level was measured in the mouth orifice by means of the built in condenser microphone. The upper curve in Fig.3.4 was obtained witout regulation and a maximum power of 3 W (4,9 V) supplied to the loudspeaker. The two lower curves were obtained with different degrees of compression. They clearly show the frequency range which can be obtained at different levels of constant SPL.

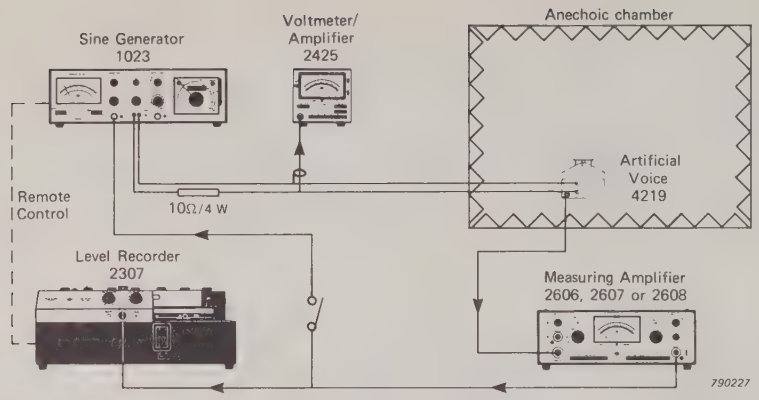


Fig.3.3. Measuring arrangement used for recording the free field frequency response of the Artificial Voice measured at the orifice

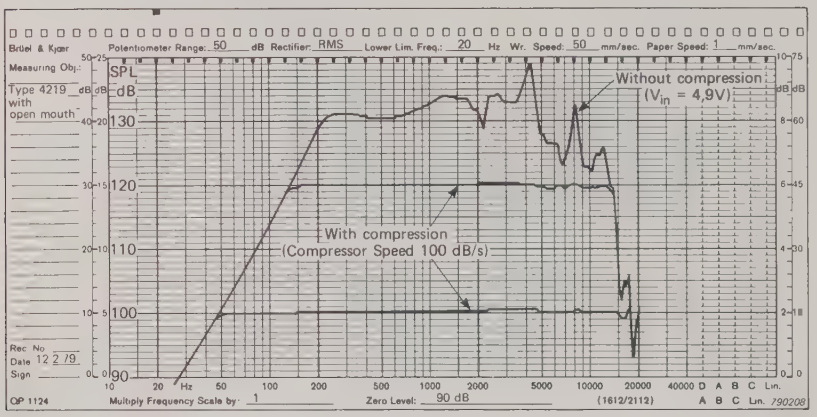


Fig.3.4. Typical frequency response curves obtained using the arrangement shown in Fig.3.3.

3.2.2. Sound Pressure Variation with Distance

The free field frequency response curves at different frequencies and distances along the axis from the Artificial Voice were measured using the set up shown in Fig.3.5. The frequency response curves are for distances (d) from 0 to 200 mm measured from the lip ring of the Voice. The sound pressure level at the mouth opening was kept constant at 115 dB re 2×10^{-5} N/m^2 by using the built in regulating Microphone Type 4136. For measurement, two microphones were used. A 1/4 inch Microphone Type 4135 for measurement at distances less than 50 mm, and a 1/2 inch Michrophone Type 4133 for measurement at greater distances. Both microphones are of the free field type, and have a linear frequency response over the range of measurements.

The variation in sound pressure with distance at a discrete frequency was measured using the same set up as in Fig.3.5. The results obtained are shown in Fig.3.7. The frequency was 200 Hz. The curves in Fig.3.6 can be used to determine the sound pressure at other frequencies and distances. At distances greater than 200 mm, the sound pressure falls approximately 6 dB every time the distance is doubled.

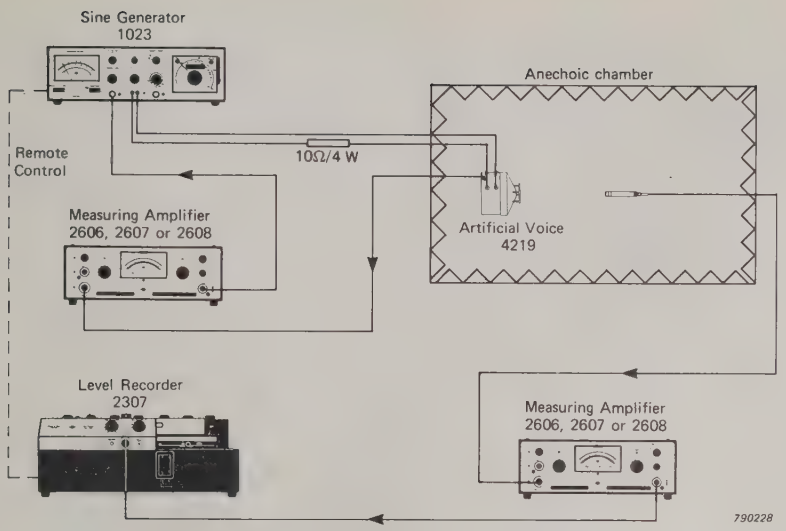


Fig.3.5. Measuring arrangement used for recording the free field frequency response of the Artificial Voice at different distances from the lip ring

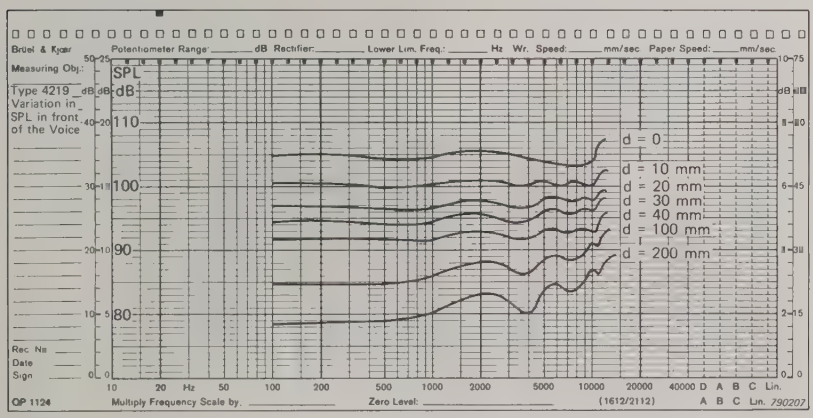


Fig.3.6. The variation of sound pressure with frequency and distance obtained using the arrangement shown in Fig.3.5

The variation of sound pressure for distances very close to the mouth is shown in Fig.3.8. The measurement was made using a continously swept signal, cycling from 200 Hz to 4 kHz and back to 200 Hz with one cycle per second. The pressure is referred to 0 dB, 40 mm from the lip ring. The measuring microphone was a 1/4 inch Microphone Type 4135, which has a free field characteristic. The built-in microphone was used for regulation.

The measured values of sound pressure variation with distance very close to the mouth, was compared with measurements by H.S. Leman on the human mouth using a test sentence (Speech Pressure Near the Human Mouth, International Congress on Acoustics IV, Copenhagen 1962, paper B 36). The pressure variation of the Artificial Voice deviates less than 0,6 dB from that of the human mouth as measured by Leman.

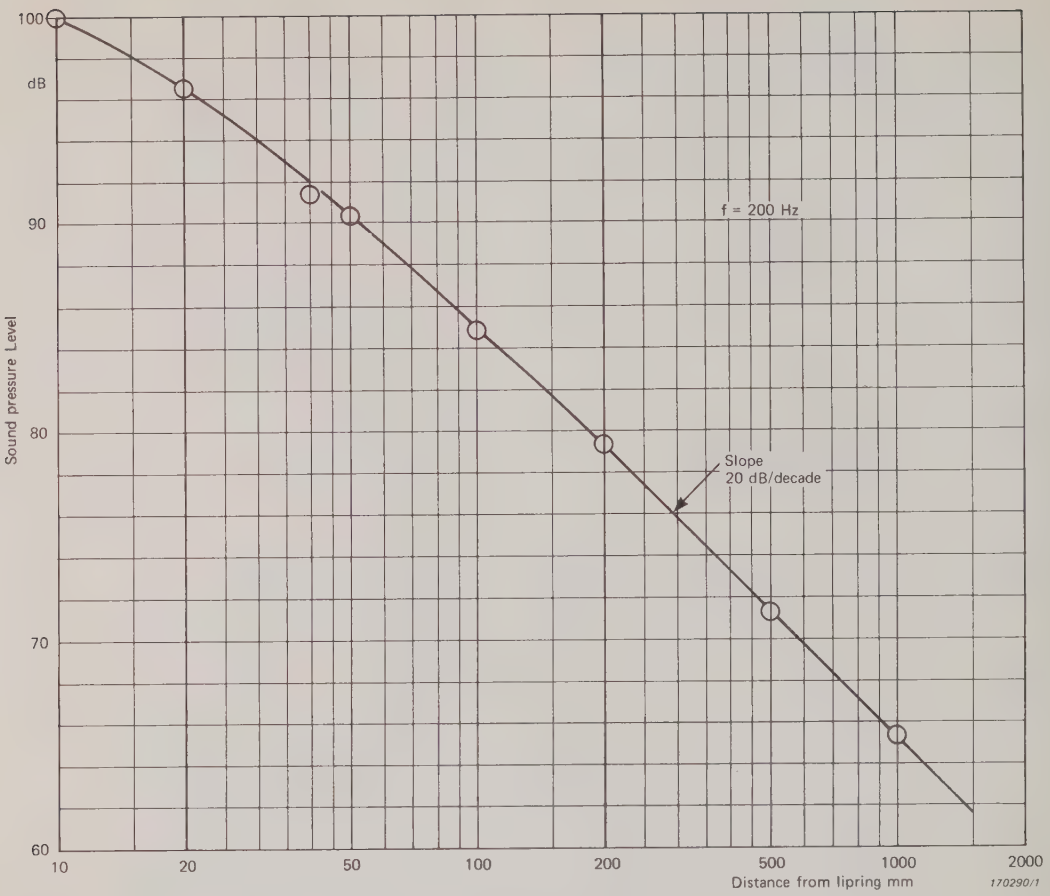


Fig.3.7. The variation of sound pressure with distance at 200 Hz measured with the arrangement shown in Fig.3.5

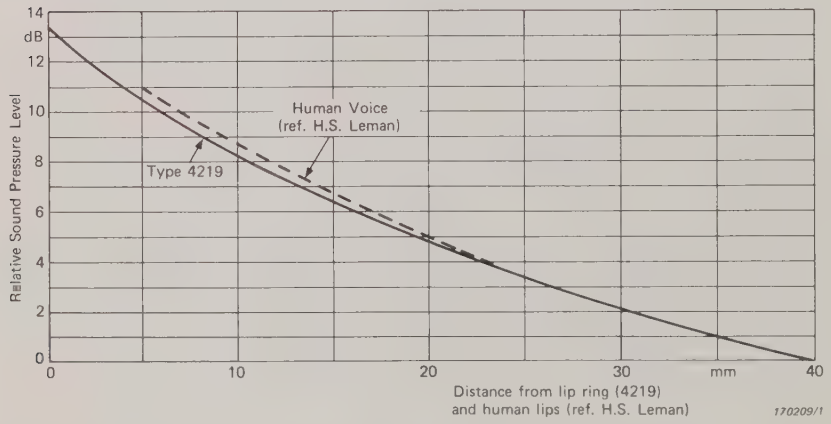


Fig.3.8. Sound field along the axis of the Voice near the orifice, compared with measurements for the mouth by H. S. Leman

3.2.3. Harmonic Distortion

The second and third harmonics of the sound pressure produced by the Voice were measured using the arrangement shown in Fig.3.9. The sound pressure level was kept constant at 100 dB re 2×10^{-5} N/m^2, by use of the compressor in the Heterodyne Analyzer Type 2010.

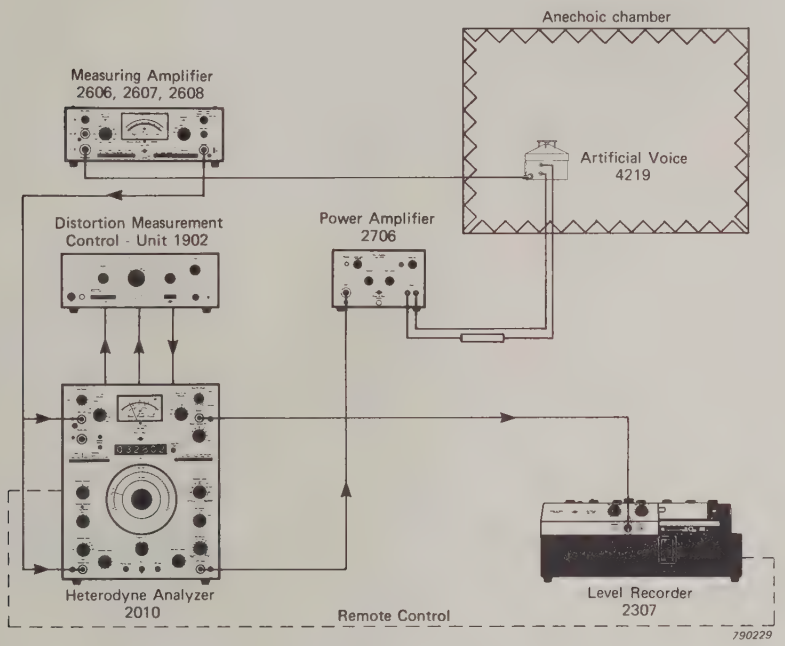


Fig.3.9. Measuring arrangement for recording the 2nd and 3rd harmonics when the Artificial Voice produces a constant sound pressure level of 100 dB

Fig.3.10 and 3.11 show the total sound pressure level at the orifice of the Voice together with the 2nd and 3rd harmonic respectively.

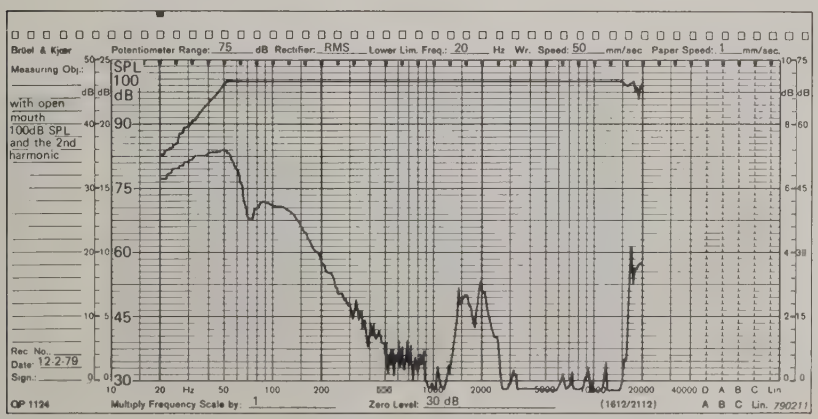

Brüel & Kjær
Potentiometer Range: 75 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 50 mm/sec Paper Speed: 1 mm/sec.
Measuring Obj.:
with open mouth 100dB SPL and the 2nd harmonic
SPL 100 dB
90
75
60
45
30
Rec. No.
Date 12-2-79
Sign.:
20 Hz 50 100 200 500 1000 2000 5000 10000 20000 40000 D A B C Lin.
QP 1124
Multiply Frequency Scale by: 1
Zero Level: 30 dB
(1612/2112)
A B C Lin. 790211

Fig.3.10. 2nd harmonic distortion for an open mouth with 100 dB SPL output

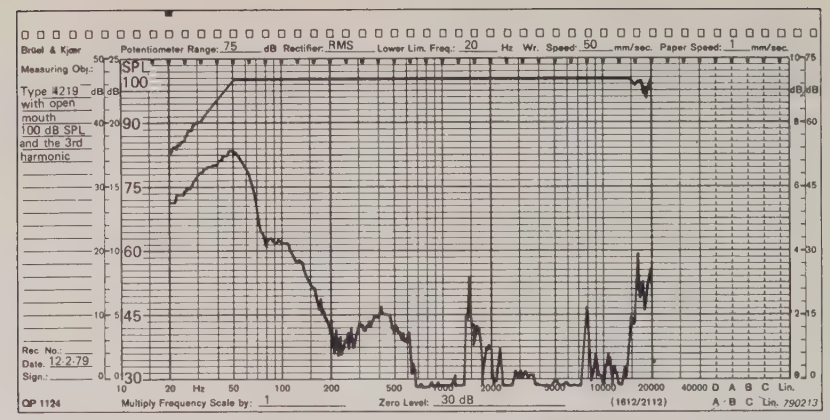

Brüel & Kjær
Potentiometer Range: 75 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 50 mm/sec. Paper Speed: 1 mm/sec.
Measuring Obj.:
Type 4219 with open mouth 100 dB SPL and the 3rd harmonic
SPL
100
90
75
60
45
30
Rec No.:
Date. 12-2-79
Sign.:
10 20 Hz 50 100 200 500 1000 2000 5000 10000 20000 40000 D A B C Lin.
QP 1124
Multiply Frequency Scale by: 1
Zero Level: 30 dB
(1612/2112)
A B C Lin. 790213

Fig.3.11. 3rd harmonic distortion for an open mouth with 100 dB SPL output

Note that the power handling capacity of the Artificial Voice is limited. If the Voice is used to generate a too high sound pressure the distortion will increase and the built-in loudspeaker may be damaged.

3.2.4. Effect of Placing an Object in the Near Field

An object placed in the near field of the Artificial Voice will have no effect on the sound pressure level in the orifice, when the Voice is used with the compressor circuit described in section 2.2. It will, however, result in a change of the voltage across the loudspeaker terminals.

The effect of the object can be seeń in Fig.3.12. The curves show the ratio of the applied voltage to the loudspeaker terminals with and without the object present. The characteristics are for distances (a) from the lip ring to the object.

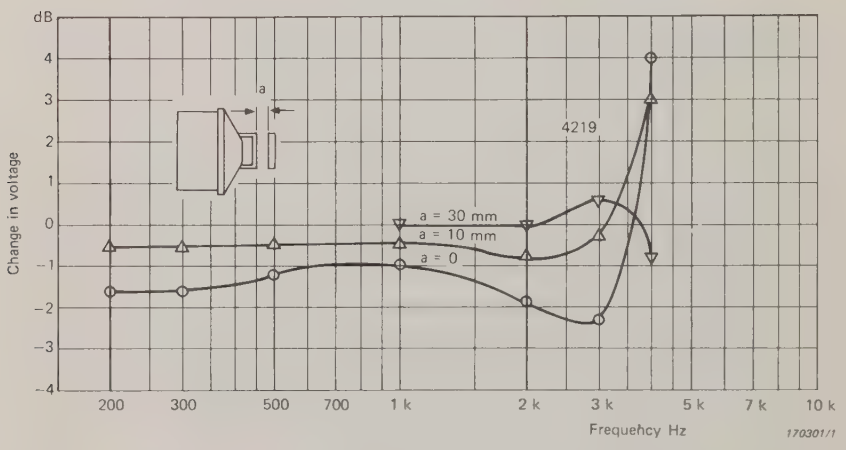


Fig.3.12. Change of voltage across the loudspeaker of the Artificial Voice when an object is presented in front of the orifice

3.3. CLOSED VOLUME CHARACTERISTICS

3.3.1. Frequency Response

The closed volume frequency response was obtained by closing the mouth orifice with a steel disc and by using the set up shown in Fig.3.13. Typical frequency response curves are shown in Fig.3.14.

The sound pressure level was measured in the mouth orifice by means of the built in condenser microphone. The upper curve in Fig.3.14 was obtained without regulation and a maximum power of 3 W (4.9 V) supplied to the loudspeaker. The two other curves show the sound pressure with different degree of compression, namely at 120 dB and 100 dB.

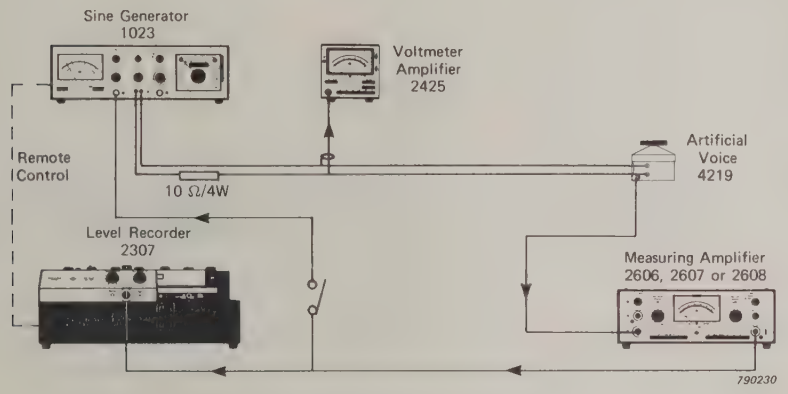


Fig.3.13. Measuring arrangement used for recording the frequency response of the Artificial Voice when the mouth is closed with a steel disc

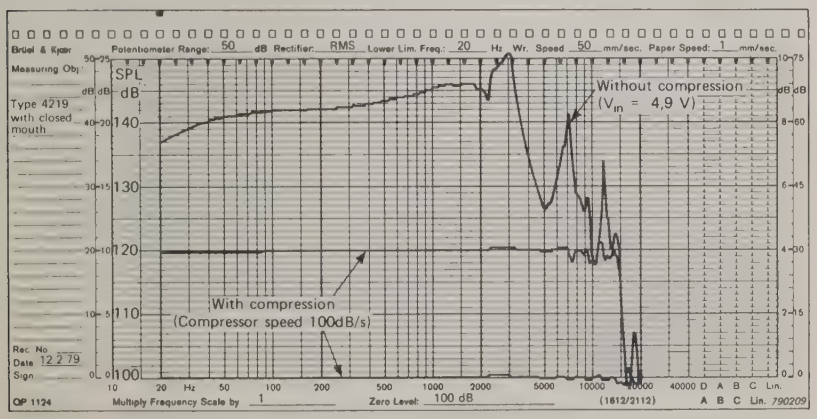


Fig.3.14. Typical frequency response curves obtained using the arrangement shown in Fig.3.13

3.3.2. Harmonic Distortion

The second and third harmonics of the sound pressure produced by the Voice was measured with the arrangement shown in Fig.3.15. The sound pressure level in the closed

mouth was kept constant at 100 dB re 2×10^{-5} N/m^2, by the use of the compressor in the Heterodyne Analyzer Type 2010. Fig.3.16 and 3.17 show the total regulated sound pressure at the orifice together with the 2nd and 3rd harmonic respectively.

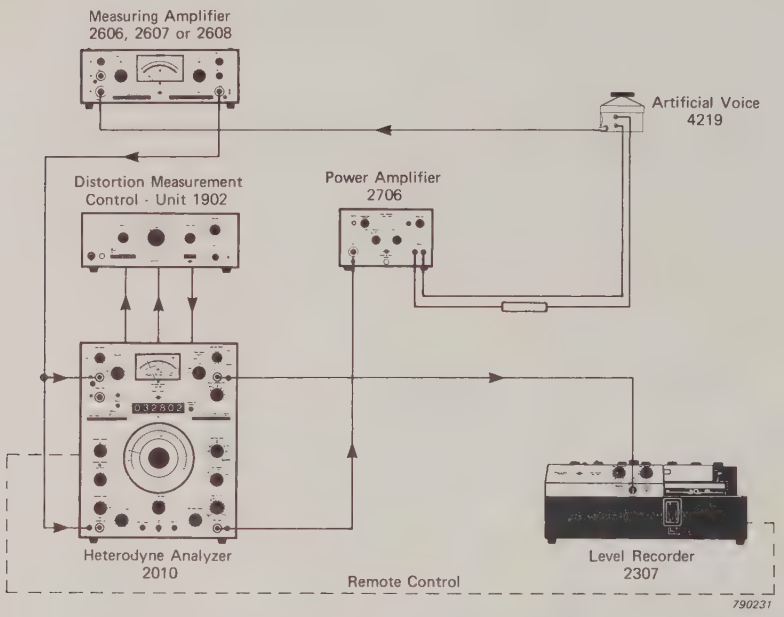


Fig.3.15. Measuring arrangement for recording the distortion when the Artificial Voice produces a constant sound pressure in the closed mouth

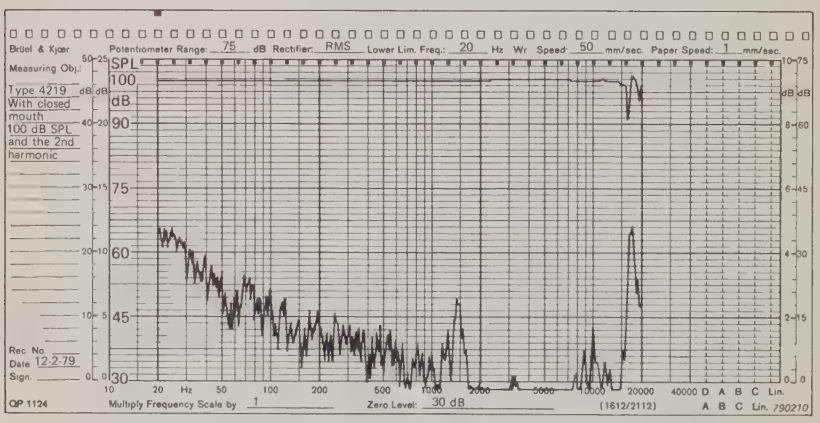
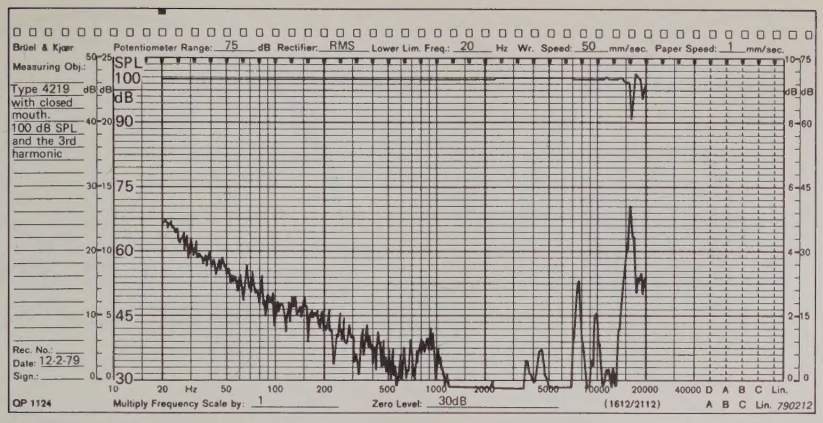


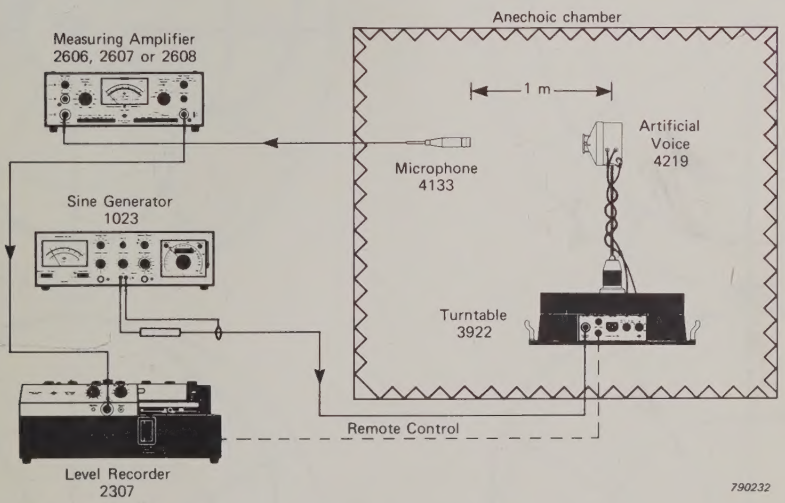
Fig.3.16. 2nd harmonic distortion for a closed mouth with 100 dB SPL output


Brüel & Kjær
Potentiometer Range: 75 dB Rectifier: RMS Lower Lim. Freq.: 20 Hz Wr. Speed: 50 mm/sec. Paper Speed: 1 mm/sec.
Measuring Obj.:
Type 4219 with closed mouth. 100 dB SPL and the 3rd harmonic
SPL dB
100
90
75
60
45
30
Rec. No.
Date: 12-2-79
Sign.:
10 20 Hz 50 100 200 500 1000 2000 5000 10000 20000 40000 D A B C Lin.
QP 1124
Multiply Frequency Scale by: 1
Zero Level: 30dB
(1612/2112)
A B C Lin.
790212

3.17. 3rd harmonic distortion for a closed mouth with 100 dB SPL output

3.4. Directivity

The angular variation of sound pressure was measured using a 1/2" Microphone Type 4133 and the set up shown in Fig.3.18. The microphone was positioned at a distance of 1 meter from the Voice. The Voice was rotated on an axis perpendicular to the symmetry of the Voice axis. The rotation axis was defined by the centre of the mounting plate, see Fig.3.1. The characteristics for different frequencies are shown in Fig.3.19.



3.18. Measuring arrangement for recording the angular variation of sound pressure at a distance of 1 meter from the Voice

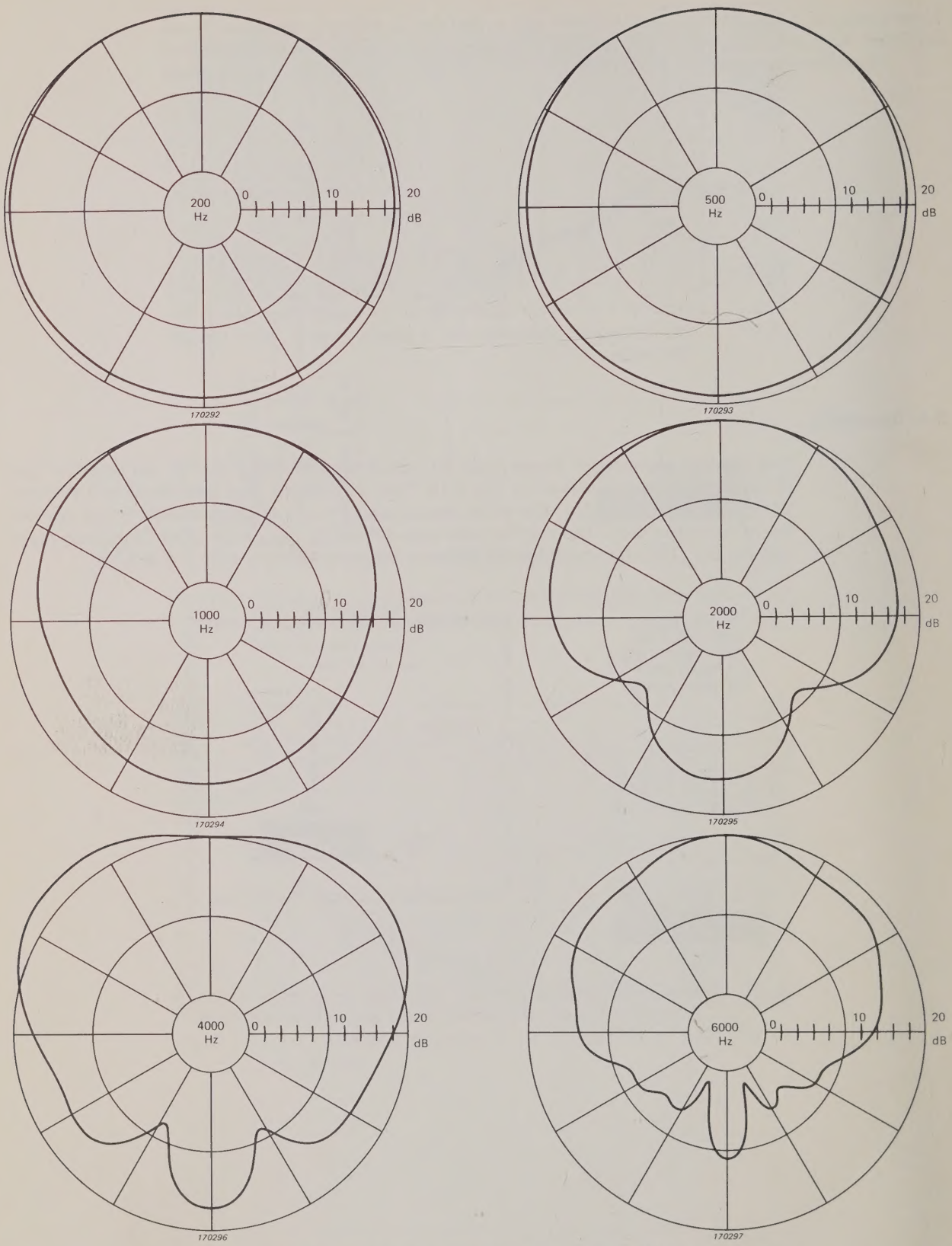
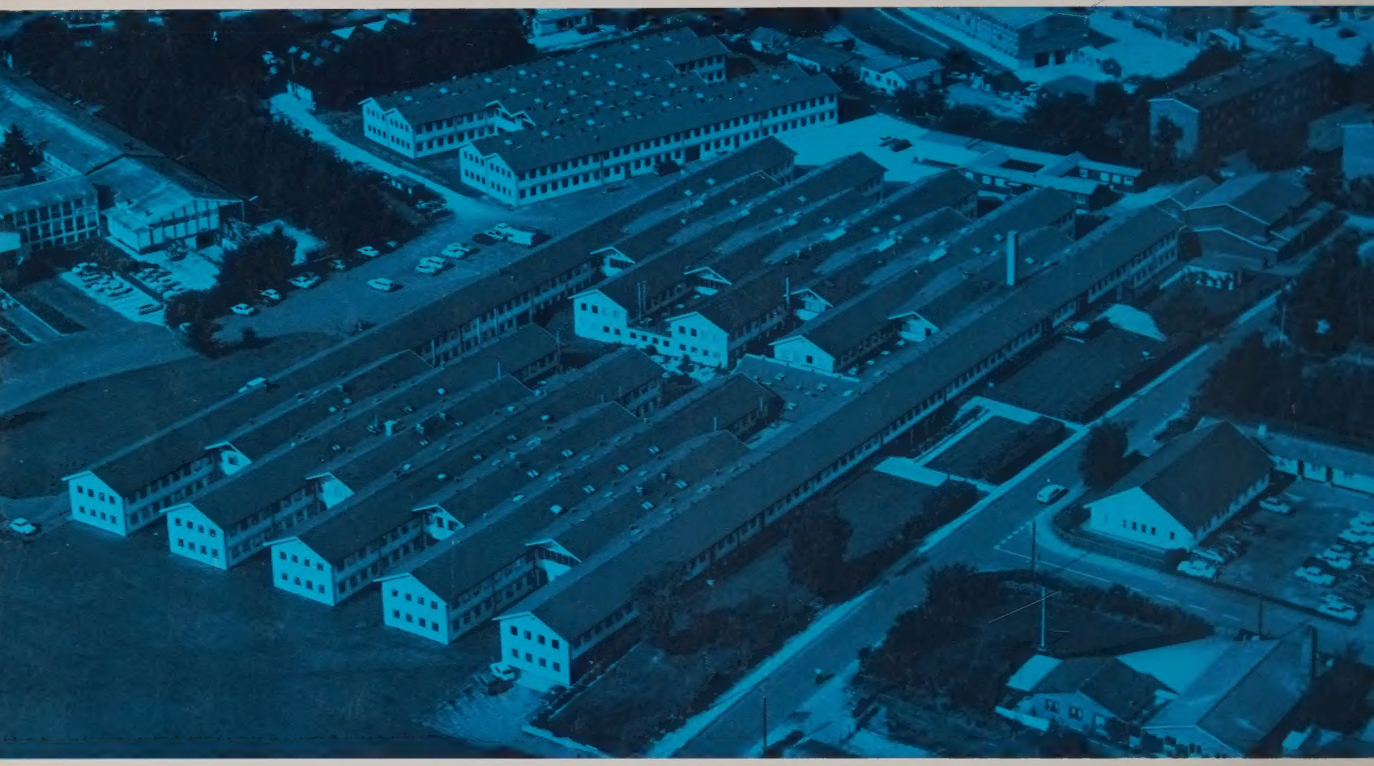


Fig.3.19. Angular variation of sound pressure at a distance of 1 meter from the Voice at various frequencies



BRÜEL & KJÆR instruments cover the whole field of sound and vibration measurements. The main groups are:

ACOUSTICAL MEASUREMENTS
Condenser Microphones
Piezoelectric Microphones
Microphone Preamplifiers
Hydrophones
Sound Level Meters
Precision Sound Level Meters
Impulse Sound Level Meters
Noise Dose Meters
Noise Level Analyzers
Standing Wave Apparatus
Calibration Equipment
Reverberation Processors
Sound Sources

ACOUSTICAL RESPONSE TESTING
Sine Generators
Random Noise Generators
Sine-Random Generators
Artificial Voices
Artificial Ears
Artificial Mastoids
Hearing Aid Test Boxes
Audiometer Calibrators
Telephone Measuring Equipment
Audio Reproduction Test Equipment
Tapping Machines
Turntables

VIBRATION MEASUREMENTS
Accelerometers
Force Transducers
Impedance Heads
Accelerometer Preamplifiers
Vibration Meters
Accelerometer Calibrators
Magnetic Transducers
Capacitive Transducers
Complex Modulus Apparatus
Bump Recorders

VIBRATION TESTING
Exciter Controls — Sine
Exciter Controls — Sine — Random
Exciter Equalizers, Random or Shock
Exciters
Power Amplifiers
Programmer Units
Stroboscopes

STRAIN MEASUREMENTS
Strain Gauge Apparatus
Multipoint Selectors

MEASUREMENT AND ANALYSIS
Voltmeters
Phase Meters
Deviation Bridges
Measuring Amplifiers
Band-Pass Filter Sets
Frequency Analyzers
Real Time Analyzers
Heterodyne Filters and Analyzers
Distortion Measuring Equipment
Psophometers
Statistical Distribution Analyzers
Tracking Filters

RECORDING
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Frequency Response Tracers
Tape Recorders
Alphanumeric Printers
Digital Event Recorders

DIGITAL EQUIPMENT
Computers
Tape Punchers
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